RESTRICTED CIRCULATION

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AGRICULTURAL MEMORANDUM NO 941

ESTIMATING PERIODS OF LEAF WETNESS FROM SYNOPTIC DATA

1. INTRODUCTION

During the spring and summer of 1981 hourly observations of meteorological parameters and visual observations of leaf wetness in a grass stand were made at Carlisle, Boulmer, Aberporth and Herstmonceux. The main objective was to test a wetness sensor but the experiment has made available about 600 station days of hourly observations. These data, now held on computer, were used to test the present algorithm for estimating periods of leaf wetness as used by the Meteorological Office for calculating plant infection criteria.

2. OPERATIONAL CRITERIA

The present method of determining periods of leaf wetness from synoptic station data, described by Adams (1977), is as follows. Leaves are deemed to be wet if any form of precipitation is reported at the time of observation or within the previous hour. They are assumed to be wet at subsequent hours if the dew-point depression is $\leqslant 1.0^{\circ}C$, roughly equivalent to 90% relative humidity.

A period ends when 2 hours elapse without these conditions being met, which permits a break of one hour. Results of the comparison between observed leaf state and estimated state using the above criteria are shown in Table 1. Leaf wetness was assessed in the top quarter of the stand and all observations in the following discussion apply to grass heights less than 30 cm.

TABLE 1 - COMPARISON OF OPERATIONAL CRITERIA WITH OBSERVED STATE OF GRASS

ESTIMATED / OBSERVED	NUMBER OF HOURS					% CORRECT	% WET
	WET WET	WET DRY	DRY WET	DRY DRY	TOTAL		
Carlisle	1059	222	804	1611	3696	72	69
Boulmer	356	93	338	605	1392	69	65
Aberporth	761	152	596	1320	2829	74	67
Herstmonceux	702	155	1250	1373	3480	60	44
TOTAL	2878	622	2988	4909	11397	68	60

Using the method outlined by Snedecor (1974) and considering the cases when the grass was reported dry, there is no significant difference between the results of each station. When the grass was reported wet there is a significant difference with the largest contribution from Herstmonceux which had only 44% estimated wet hours compared with the total number of observed wet hours.

Tests of the leaf wetness sensor reported by Wass (1982) showed there to be no difference in the standard of observing so this discrepancy must be attributed to the weakness of the algorithm. Since the critical relative humidity is based to some extent on a paper by Hearn (1961) who correlated periods of surface wetness with humidity $\geqslant$ 90% and these correlations were for 10 day periods then some imprecision may be expected.

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3. OTHER CRITERIA

Inspection of the observations revealed that most occurrences of a failure to predict leaf wetness were due to either the inability to predict dew formation or to an underestimate of the persistence of free water at night.

Under clear sky conditions Pedro (1981) achieved excellent predictions of dew formation and dispersal using a relatively simple energy balance model. The model was less reliable when trying to simulate conditions with cloud cover and did not have to deal with the added uncertainty of ground heat flux since observations were taken at least 0.6 m above ground.

Working initially with the Carlisle data set no significant correlations could be found between the persistence of free water and windspeed, cloud cover or sunshine duration. Various combinations of night-time dew-point depressions (to predict the onset of dew) and both day and night dew-point depressions to predict the evaporation of free water were tried and the results are presented in Table 2.

TABLE 2 - COMPARISON OF LEAF WETNESS CRITERIA

PREDICTED OBSERVED	TOTAL NUMBER OF HOURS						CRITERIA TESTED			
	WET WET	WET DRY	DRY WET	DRY DRY	PERCENTAGE CORRECT	PERCENTAGE PREDICTED WET	BROKEN PERIOD	DEW-POINT DEPRESSION NIGHT DEW FORMS	DEW-POINT DEPRESSION NIGHT WATER EVAPORATES	DEW-POINT DEPRESSION DAY WATER EVAPORATES
OPERATIONAL	1059	222	804	1611	72	69	YES	NONE	1.0	1.0
	1846	1103	17	730	70	158	YES	NONE	3.0	3.0
	1377	309	486	1524	78	90	YES	NONE	2.0	2.0
	1277	175	586	1658	79	78	NO	NONE	2.0	2.0
	1612	380	251	1453	83	107	NO	2.5	3.0	1.0
	1688	407	175	1426	84	112	NO	2.5	3.0	2.0
SUGGESTED CRITERIA	1586	280	277	1553	85	100	NO	1.5	3.0	2.0

To improve the criteria the number of correct estimates has to be maximised whilst the incorrect ones have to be balanced between estimating wet when the grass is dry and estimating dry when the grass is wet. Fortunately both conditions occur with the same criteria as shown in the last line of Table 2. This is an improvement from 72% to 85% in the number of correct hours and an improvement from 69% to 100% in the number of estimated wet hours as compared with the total number of wet hours.

These same criteria applied to all 4 stations (Table 3) show an improvement in the estimates, the most marked being that for Herstmonceux.

TABLE 3 - COMPARISON OF IMPROVED CRITERIA WITH OBSERVED STATE OF GRASS

ESTIMATED OBSERVED	NUMBER OF HOURS WET WET	WET DRY	DRY WET	DRY DRY	TOTAL	% CORRECT	% WET
Carlisle	1586	280	277	1553	3696	85	100
Boulmer	619	151	75	547	1392	84	111
Aberporth	1419	461	239	1358	3477	80	113
Herstmonceux	1583	181	369	1347	3480	84	90
TOTAL	5207	1073	960	4805	12045	83	102

A comparison of the ratios of wet to dry estimates still shows there to be a significant difference between stations though not as large as with the original operational criteria. This emphasises the difficulty in obtaining a universal algorithm. As the variability cannot now be attributed to a single station it is suggested that the criteria have shown an improvement significant enough to become operational.

4. IMPROVED LEAF WETNESS CRITERIA

Leaves become wet if precipitation is reported or at night when the dew-point depression $\leq 1.5^{\circ}C$. Leaves dry when the dew-point depression is greater than $3.0^{\circ}C$ at night and $2.0^{\circ}C$ by day.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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